

## Doctoral Program in Physics

| Name of the degree to be conferred  | Doctor of Philosophy in Science   |
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| Educational purpose   | The Doctoral Program in Physics is designed to help students discover problems willingly and develop the ability to research and solve them through learning to carry out leading-edge physical research under their initiative so that the Program cultivates human resources who are capable of being active as an independent researcher in academia and also industry.  |
| Vision of human resources development   | <p>He or she should possess not only the qualities in physics but also the knowledge about the areas of associated disciplines and also the ability to scientifically challenge and break through problems that should be elucidated and solved.</p> <p>In academia, he or she should possess advanced specialized knowledge and real research ability and be capable of making strides in the frontier of science in the extensive areas of physics that spread out from the architecture of the universe to the materials world and in their boundary areas with other disciplines. In the industrial field, he or she should be capable of making innovations in industrial technologies by going back to the first principles of things to challenge difficult issues that no one could have solved.</p> <p>In the course of the history of the universe, the Program adopts a system of education that crosses over international research bases based on the viewpoint of seeing the disciplinary areas of particle physics, nuclear physics and physical cosmology as the evolution processes of the universe in order to thereby cultivate human resources who possess the interdisciplinary ability to involve all these areas along with a high level of expertise and are capable of being internationally active concerning the history of the universe.</p> <p>In the course of accelerator science, he or she should be capable of being active in this field in the future, through the research and next-generation accelerator development using the B-factory, J-PARC and accelerator-based synchrotron radiation science research facility of High Energy Accelerator Research Organization, etc.</p> <p>In the course of synchrotron radiation materials science, he or she should gain knowledge and skill in both areas of synchrotron radiation, etc. in addition to materials science through the research utilizing synchrotron radiation facilities (for example, PF, J-PARC, SPring-8 and overseas facilities), etc. and be capable of promoting materials development at universities or institutes inside and outside Japan, synchrotron radiation facilities or private sector companies.</p> |
| Competencies specified in diploma policy  | Evaluation perspectives   |
| 1. Knowledge creation competence: Ability to create new knowledge that can contribute to future society   | <p>① Are there any research findings that can be considered new knowledge?</p> <p>② Can we expect you to create knowledge that will contribute to future society?</p>   |
| 2. Management competence: Ability to plan and implement measures to identify and solve challenges from a higher perspective                                 | <p>① Can you make and implement long-term plans for critical challenges?</p> <p>② Can you identify challenges, even in other areas of expertise, and solve them from a higher perspective?</p>  |
| 3. Communication competence: Ability to express the true nature of academic findings positively and clearly   | <p>① Can you explain the true nature of research content and specialized knowledge clearly and logically to researchers from different areas and to people other than researchers?</p> <p>② Do you proactively share your findings with researchers and experts from your field of expertise and accurately answer questions?</p>   |
| 4. Leadership competence: Ability to have objectives get accomplished under your leadership   | <p>① Can you set attractive and compelling goals?</p> <p>② Are you capable of building systems to realize goals and accomplish objectives as the leader?</p>  |
| 5. Internationality competence: Possession of a high level of awareness and motivation to be internationally active and contribute to international society | <p>① Do you have strong awareness and motivation to contribute to international society and international activities?</p> <p>② Have you obtained adequate linguistic skills for international information collection and action?</p>  |

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| 6. Creative ability: Fundamental abilities to create physical knowledge to contribute to human society development by identifying a universal structure in the natural setting | ①If problems are raised in consideration of the relationship between physics and society using wide knowledge in the areas of physics<br>②If concrete measures contributory to the society are proposed using the knowledge in their own area of expertise |
| 7. Physical ability: Leading-edge scholarly knowledge and the ability to debate and conduct joint research with researchers inside and outside Japan                           | ①If the basic specialized knowledge in the areas of physics was gained and physical phenomena are addressed with logical thinking<br>②If the advanced specialized knowledge in one's own area of research was gained and research is thereby carried out   |
| 8. Ability to carry out: Ability to independently carry out ingenious research developed out of one's own area of expertise further  | ①If the trends in one's own area of expertise are closely watched and academic significance is grasped from a broad view<br>②If one's own research is judged objectively and new strides are created   |
| 9. Information provision ability: Ability to provide a clear description of one's research to those from different areas and not just one's own area                           | ①If the academic importance of one's own research is explained in an appealing way<br>②If a description of concepts peculiar to physics is made clear in a persuasive way to those from different areas and not just one's own area                        |
| 10. Logical ability: Dedication to duty, logicity and independence as a scientist  | ①If one is enthusiastic about searching for natural truth, and corresponding action is accompanied<br>②If the planning, methodology, execution and confirmation of research are scientific and sincere   |

#### Dissertation evaluation criteria

##### 【Review board members】

Structure of thesis review board

Set up with one chief reviewer and three or more sub-reviewers.

##### 【Review method】

Prior to the receipt of a degree thesis, to determine the acceptance of the submission, the degree thesis is preliminarily reviewed. The dissertation review board administers dissertation review and the final exam or the confirmation of academic abilities. The final exam includes the evaluation of the ability for presenting one's research content to those from different areas and not just one's own area and the ability to have disciplinary communication with researchers from different areas and not just one's own area.

##### 【Review items】

1. Grasping and understanding of preceding researches associated with one's research content, and the appropriate appraisal and citation of their literature and materials
2. Setting of appropriate research tasks, and the clear presentation of research method and its appropriateness
3. Reproducibility of obtained results, or verifiability by third parties
4. Unequivocal thesis construction, and appropriate development of line of reasoning before reaching the conclusion
5. International-level academic contribution

##### 【Level standards required for the degree thesis】

With the adherence to research ethics, all of the above evaluation items must be met. As for evaluation item ⑤, the degree dissertation must be written in English in principle, and if its overview has not been presented in any international academic journal, it must be presented within one year after the date of the grant of degree. The dissertation passes as a doctoral dissertation with the above requirements and the final exam or the confirmation of academic abilities included in the judgment.

#### Curriculum Policy

The Program consists of a total of ten areas of expertise, which are theoretical particle physics, experimental particle physics, cosmology, observational cosmology, theoretical nuclear physics, experimental nuclear physics, theoretical condensed matter physics, experimental condensed matter physics, biophysics, and plasma physics, and a total of three realms, which are the history of the universe, accelerator science, and synchrotron radiation materials science.

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| Curriculum organization policy  | <p>In the areas of particle physics, nuclear physics and astrophysics, the course of the history of the universe is organized for a system of education crossing over international research bases. In the areas of condensed matter physics, the Program organizes the course of synchrotron radiation materials science, where students can acquire the knowledge and skill in synchrotron radiation application which serves as a powerful technique for the search in materials science, through the cooperation of Japan Synchrotron Radiation Research Institute and Photon Factory. In addition, the course of accelerator science is organized through the education and research tie-up with High Energy Accelerator Research Organization.</p> <p>Since physics is the foundation of natural science, the Program in Physics is deeply interrelated in research and education with other Programs of Graduate School, and research centers (Center for Computational Science, Tomonaga Center for the History of the Universe, Tsukuba Research Center for Energy Materials Science, Plasma Research Center, etc.) as well as major research institutes inside and outside Japan. Taking advantage of this characteristic, the Program provides various education programs, including the Cooperative Graduate School System (National Institutes for Quantum and Radiological Science and Technology, National Institute of Advanced Industrial Science and Technology, National Institute for Materials Science, RIKEN, NTT, NEC, etc.) and Tsukuba Resonance Education Program.</p> <ul style="list-style-type: none"> <li>• Students belong to their respective area of specialty and thereby gain a high level of expertise.</li> <li>• By taking special research subjects of each area, students acquire a wide perspective, and through the deepening of each one's original research theme, develop fundamental and applied abilities and fortitude as a researcher.</li> <li>• In addition, students acquire practical abilities with information provision/communication ability development subjects in Graduate General Education Courses.</li> </ul> |
| Learning methods · Processes    | <p>Students belong to any of the laboratories of their respective area of specialty. By taking special research subjects of each area, students acquire a wide perspective, and through the deepening of each one's original research theme, develop fundamental and applied abilities and fortitude as a researcher, so that they can proceed as independent researchers.</p>   |
| Evaluation of learning outcomes | <ul style="list-style-type: none"> <li>• Special research as required subject: In special research, students are evaluated for the achievements as to specialized knowledge, foundations in associated areas, wide perspective, problem identification in reality to solution, presentation and communication abilities, international compatibility, academic outcomes and all other evaluation items through the experience of attending a special interest group, academic conference, international conference, etc. or studying abroad, etc. in addition to routine activities such as seminars, debates and literature introduction.</li> <li>• Review of dissertation: In the dissertation presentation and oral exam at the dissertation review, students are evaluated for the achievements as to problem identification in reality to solution, presentation and communication abilities, international compatibility, academic outcomes and other evaluation items.</li> </ul>  |
| <b>Admission Policy</b>         |  |
| Desired students                | <p>We seek candidates who have master's degree level skills in physics and its associated scientific areas and English proficiency, have the great interest and motivation to conduct leading-edge research in the areas of physics and pursue to be a researcher in academia and industry.</p>  |
| Selection policy                | <p>Selection places emphasis on the master's thesis content and post-enrollment research plan.</p>   |